RESTRICTED CIRCULATION

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AGRICULTURAL MEMORANDUM NO 783

Estimation of Areal Return Dates

H Drinkwater

Data for about 100 stations are regularly used to estimate monthly soil moisture balances. The average potential transpiration for each station was found by adjusting according to station height; average annual rainfalls are known. The average return date was then calculated using the formulae in Ag. Mem No. 782.

The algebraic difference between station and areal averages of return date gives a conversion factor which can be used in the estimation of the areal value of return date from current station values. This estimation uses weighted values from stations in and outside the area, namely, 1 for stations inside the area and $\frac{1}{2}$ for stations from surrounding areas.

The formulae for estimating areal values are given in the Appendix.

High level areas with no return date average are omitted.

Any comments or suggestions on this paper should be referred to the author.

Meteorological Office
Bracknell

January 1976

APPENDIX

AREA	FORMULA
1A	$\frac{1}{1.5}\left[(\text{Seahouses} - 1.1) + \frac{1}{2}(\text{Boulmer} - 1.0)\right]$
1B	$\frac{1}{2}\left[(\text{Boulmer} - 1.2) + \frac{1}{2}(\text{Seahouses} - 1.3) + \frac{1}{2}(\text{Durham} - 0.6)\right]$
2	$\frac{1}{3}\left[(\text{Redesdale} + 0.3) + (\text{Kielder Castle} + 1.4) + \frac{1}{2}(\text{Carlisle} - 2.3) + \frac{1}{2}(\text{Haydon Bridge} - 4.0)\right]$
3	$\frac{1}{3.5}\left[(\text{Carlisle} - 2.0) + (\text{Sellafield} + 0.4) + \frac{1}{2}(\text{Kielder Castle} + 1.7) + \frac{1}{2}(\text{Grizedale} + 5.8) + \frac{1}{2}(\text{Cartmel} - 0.9)\right]$
4	$\frac{1}{2.5}\left[(\text{Haydon Bridge} - 4.5) + (\text{Ilkley} - 2.2) + \frac{1}{2}(\text{N ewton Rigg} - 1.4)\right]$
5	$\frac{1}{3.5}\left[(\text{Durham} - 0.4) + \text{Leeming} - 1.7) + \frac{1}{2}(\text{Boulmer} - 1.0) + \frac{1}{2}(\text{Haydon Bridge} + 1.5) + \frac{1}{2}(\text{Pickering} - 0.2)\right]$
6	$\frac{1}{3}\left[(\text{Malham Tarn} - 1.1) + (\text{Grizedale} + 0.1) + \frac{1}{2}(\text{Sellafield} - 5.3) + \frac{1}{2}(\text{Nelson} - 5.8)\right]$
7	$\frac{1}{3.5}\left[(\text{Silpho Moor} + 0.6) + (\text{Pickering} - 3.8) + \frac{1}{2}(\text{Durham} - 4.0) + \frac{1}{2}(\text{Leeming} - 5.3) + \frac{1}{2}(\text{High Mowthorpe} - 1.1)\right]$
8	$\frac{1}{5}\left[(\text{Cartmel} - 0.5) + (\text{Kirkham} - 2.1) + (\text{Nelson} + 0.3) + \frac{1}{2}(\text{Sellafield} + 0.8) + \frac{1}{2}(\text{Squires Gate} - 3.4) + \frac{1}{2}(\text{Ringway} - 3.2) + \frac{1}{2}(\text{Buxton} + 2.7)\right]$
9	$\frac{1}{4}\left[(\text{Speke} - 0.9) + (\text{Squires Gate} - 0.2) + \frac{1}{2}(\text{Kirkham} + 1.1) + \frac{1}{2}(\text{Ringway}) + \frac{1}{2}(\text{Hawarden Bridge} - 2.9) + \frac{1}{2}(\text{Cartmel} + 2.7)\right]$
10	$\frac{1}{3.5}\left[(\text{Huddersfield} - 1.2) + (\text{Buxton} + 1.3) + \frac{1}{2}(\text{Nelson} - 1.1) + \frac{1}{2}(\text{Sheffield} - 3.6) + \frac{1}{2}(\text{Ilkley} - 2.8)\right]$
11	$\frac{1}{4.5}\left[(\text{Ilkley} + 1.3) + (\text{Bradford} + 0.9) + (\text{Sheffield} + 0.5) + \frac{1}{2}(\text{Huddersfield} + 2.9) + \frac{1}{2}(\text{Nelson} + 3.0) + \frac{1}{2}(\text{Harrogate} - 0.6)\right]$

AREA	FORMULA
12	$\frac{1}{3.5}\left[(\text{Askham Bryan} - 0.4) + (\text{Harrogate} + 2.9) + \frac{1}{2}(\text{Leeming} - 0.3) + \frac{1}{2}(\text{High Mowthorpe} + 3.9) + \frac{1}{2}(\text{Finningley} - 3.1)\right]$
13	$\frac{1}{3.5}\left[(\text{High Mowthorpe} + 3.7) + (\text{Hull} - 0.3) + \frac{1}{2}(\text{Pickering} + 1.0) + \frac{1}{2}(\text{Askham Bryan} - 0.6) + \frac{1}{2}(\text{Binbrook} + 0.4)\right]$
14	$\frac{1}{4}\left[(\text{Hawarden Bridge} - 2.3) + (\text{Ringway} + 0.6) + \frac{1}{2}(\text{Speke} - 0.3) + \frac{1}{2}(\text{Ruthin} - 0.7) + \frac{1}{2}(\text{Shawbury} - 2.9) + \frac{1}{2}(\text{Stone} - 0.9)\right]$
15A	$\frac{1}{3}\left[(\text{Stone} - 2.6) + \frac{1}{2}(\text{Ringway} - 1.1) + \frac{1}{2}(\text{Walsall} - 2.2) + \frac{1}{2}(\text{Morley} - 3.2) + \frac{1}{2}(\text{Penkridge} - 3.9)\right]$
15B	$\frac{1}{3}\left[(\text{Morley}) + \frac{1}{2}(\text{Stone} + 0.6) + \frac{1}{2}(\text{Sutton Bonington} - 2.9) + \frac{1}{2}(\text{Newtown Linford} - 0.8) + \frac{1}{2}(\text{Walsall} + 1.0)\right]$
16	$\frac{1}{5}\left[(\text{Finningley} - 1.6) + (\text{Sutton Bonington} - 0.5) + (\text{Warsop} - 0.5) + \frac{1}{2}(\text{Askham Bryan} + 1.1) + \frac{1}{2}(\text{Cranwell} - 0.9) + \frac{1}{2}(\text{Wittering} - 0.8) + \frac{1}{2}(\text{Newtown Linford} + 1.6)\right]$
17A	$\frac{1}{4}\left[(\text{Wittering} - 0.2) + (\text{Cranwell} - 0.3) + \frac{1}{2}(\text{Finningley} - 1.0) + \frac{1}{2}(\text{Binbrook} + 2.7) + \frac{1}{2}(\text{Terrington St Clement} - 0.7) + \frac{1}{2}(\text{Sutton Bonington} + 0.1)\right]$
17B	$\frac{1}{3.5}\left[(\text{Binbrook} - 1.3) + (\text{Skegness} - 1.5) + \frac{1}{2}(\text{Hull} + 0.6) + \frac{1}{2}(\text{Terrington St.Clement} - 2.1) + \frac{1}{2}(\text{Cranwell} - 1.7)\right]$
18A	$\frac{1}{4}\left[(\text{Shawbury} - 2.4) + (\text{Oswestry} + 2.1) + \frac{1}{2}(\text{Hawarden Bridge} - 1.8) + \frac{1}{2}(\text{Stone} - 0.4) + \frac{1}{2}(\text{Hampton Loade} - 2.1) + \frac{1}{2}(\text{Stoke St. Milborough} + 1.7)\right]$
18B	$\frac{1}{2.5}\left[(\text{Stoke St. Milborough} - 0.2) + \frac{1}{2}(\text{Oswestry} + 0.2) + \frac{1}{2}(\text{Hampton Loade} - 4.0) + \frac{1}{2}(\text{Malvern} - 2.7)\right]$
19	$\frac{1}{4}\left[(\text{Penkridge} - 0.2) + (\text{Hampton Loade} - 0.6) + \frac{1}{2}(\text{Shawbury} - 0.9) + \frac{1}{2}(\text{Stone} + 1.1) + \frac{1}{2}(\text{Walsall} + 1.5) + \frac{1}{2}(\text{Pershore} - 2.9)\right]$

AREA	FORMULA
20	$\frac{1}{3.5}$ [(Elmdon - 0.4) + (Walsall + 1.5) + $\frac{1}{2}$ (Penkridge - 0.2) + $\frac{1}{2}$ (Newtown Linford - 0.3) + $\frac{1}{2}$ (Pershore - 2.9)]
21	$\frac{1}{4}$ [(Wellesbourne - 1.8) + (Pershore - 1.9) + $\frac{1}{2}$ (Elmdon + 0.6) + $\frac{1}{2}$ (Brize Norton + 1.2) + $\frac{1}{2}$ (Cheltenham - 0.3) + $\frac{1}{2}$ (Malvern + 1.7)]
22A	$\frac{1}{4}$ [(Newtown Linford + 0.4) + (Bugbrooke Mills - 1.5) + $\frac{1}{2}$ (Wellesbourne - 2.1) + $\frac{1}{2}$ (Sutton Benington - 1.7) + $\frac{1}{2}$ (Raunds - 2.2) + $\frac{1}{2}$ (Caldecott - 2.9)]
22B	$\frac{1}{4}$ [(Raunds - 1.0) + (Caldecott + 1.7) + $\frac{1}{2}$ (Bugbrooke Mills - 0.3) + $\frac{1}{2}$ (Wittering - 1.0) + $\frac{1}{2}$ (Silsoe - 1.9) + $\frac{1}{2}$ (N.I.A.B. - 1.7)]
23	$\frac{1}{2.5}$ [(Terrington St. Clement) + $\frac{1}{2}$ (Skegness + 0.6) + $\frac{1}{2}$ (Marham + 1.0) + $\frac{1}{2}$ (Wittering + 0.3)]
24	$\frac{1}{5}$ [(Marham) + (Lowestoft - 0.4) + (Cromer + 0.3) + $\frac{1}{2}$ (Terrington St.Clement - 1.0) + $\frac{1}{2}$ (N.I.A.B. - 1.4) + $\frac{1}{2}$ (Wattisham - 0.5) + $\frac{1}{2}$ (Honington - 0.7)]
25A	$\frac{1}{3.5}$ [(Preston Wynne - 2.1) + (Malvern - 0.4) + $\frac{1}{2}$ (Stoke St. Milborough + 2.1) + $\frac{1}{2}$ (Pershore - 4.0) + $\frac{1}{2}$ (Cheltenham - 2.4)]
25B	$\frac{1}{4}$ [(Usk + 0.4) + (Crumbland Plantation + 1.3) + $\frac{1}{2}$ (Preston Wynne - 4.3) + $\frac{1}{2}$ (Cheltenham - 4.6) + $\frac{1}{2}$ (Rhoose - 4.4) + $\frac{1}{2}$ (Long Ashton - 0.9)]
26	$\frac{1}{4}$ [(Little Rissington + 1.1) + (Brize Norton- 0.4) + $\frac{1}{2}$ (Cheltenham - 1.9) + $\frac{1}{2}$ (Pershore - 3.5) + $\frac{1}{2}$ (Lyneham - 0.2) + $\frac{1}{2}$ (Wellesbourne - 3.4)]

AREA	FORMULA
27	$\frac{1}{4}$ [(Aylesbury - 1.0) + (Hurley + 0.3) + $\frac{1}{2}$ (Brize Norton + 0.8) + $\frac{1}{2}$ (Silsoe - 2.8) + $\frac{1}{2}$ (Rothamsted + 0.5) + $\frac{1}{2}$ (Benson - 1.0)]
28	$\frac{1}{5}$ [(Wittering + 0.2) + (N.I.A.B.- 0.5) + (Silsoe - 0.7) + $\frac{1}{2}$ (Raunds + 0.2) + $\frac{1}{2}$ (Terrington St. Clement - 0.1) + $\frac{1}{2}$ (Honington + 0.2) + $\frac{1}{2}$ (Rothamsted + 2.6)]
29	$\frac{1}{5}$ [(Stansted + 0.7) + (Henington - 0.1) + (Wattisham + 0.1) + $\frac{1}{2}$ (Lowestoft + 0.2) + $\frac{1}{2}$ (Clacton - 0.8) + $\frac{1}{2}$ (N.I.A.B. - 0.8) + $\frac{1}{2}$ (Marham + 0.6)]
30	$\frac{1}{5}$ [(Long Ashton + 0.9) + (Lyneham - 1.1) + (Cheltenham - 2.8) + $\frac{1}{2}$ (Usk + 2.2) + $\frac{1}{2}$ (Pershore - 4.4) + $\frac{1}{2}$ (Marlborough + 0.1) + $\frac{1}{2}$ (Cannington - 1.7)]
31A	$\frac{1}{3}$ [(Benson - 1.3) + $\frac{1}{2}$ (Lyneham + 1.1) + $\frac{1}{2}$ (Brize Norton + 0.9) + $\frac{1}{2}$ (Aylesbury - 1.3) + $\frac{1}{2}$ (Long Sutton + 1.8)]
31B	$\frac{1}{4}$ [(Leckford) + (Long Sutton + 0.1) + $\frac{1}{2}$ (Benson - 3.0) + $\frac{1}{2}$ (Shinfield - 2.5) + $\frac{1}{2}$ (Southampton - 0.5) + $\frac{1}{2}$ (Boscombe Down - 1.0)]
32	$\frac{1}{4}$ [(Wisley - 1.2) + (Shinfield - 1.2) + $\frac{1}{2}$ (Benson - 1.7) + $\frac{1}{2}$ (Hurley - 0.4) + $\frac{1}{2}$ (Edenbridge + 0.5) + $\frac{1}{2}$ (North Heath + 0.4)]
33A	$\frac{1}{3}$ [(Rothamstead + 1.1) + $\frac{1}{2}$ (Aylesbury - 0.4) + $\frac{1}{2}$ (Silsoe - 2.2) + $\frac{1}{2}$ (Stansted - 0.5) + $\frac{1}{2}$ (Writtle - 2.0)]
33B	$\frac{1}{3.5}$ [(Writtle - 0.2) + (Clacton - 0.2) + $\frac{1}{2}$ (Rothamsted + 2.9) + $\frac{1}{2}$ (Wattisham + 0.7) + $\frac{1}{2}$ (Gillingham + 0.8)]

AREA	FORMULA
34	$\frac{1}{3.5}\left[(\text{Gillingham} - 0.8) + (\text{Faversham} + 0.6) + \frac{1}{2}(\text{Writtle} - 1.8) + \frac{1}{2}(\text{Manston} - 0.6) + \frac{1}{2}(\text{East Malling} + 0.6)\right]$
35	$\frac{1}{4}\left[(\text{Cannington} - 1.9) + (\text{Cheldon Barton} + 1.6) + \frac{1}{2}(\text{Long Ashton} + 0.7) + \frac{1}{2}(\text{Exeter} - 1.5) + \frac{1}{2}(\text{Ilfracombe} + 2.3) + \frac{1}{2}(\text{Lyneham} - 1.3)\right]$
36	$\frac{1}{4}\left[(\text{Boscombe Down} - 1.3) + (\text{Marlborough} + 0.3) + \frac{1}{2}(\text{Lyneham} - 0.9) + \frac{1}{2}(\text{Leckford} - 0.3) + \frac{1}{2}(\text{Shaftesbury} + 0.7) + \frac{1}{2}(\text{Cheldon Barton} + 2.0)\right]$
37A	$\frac{1}{3}\left[(\text{North Heath} - 0.5) + \frac{1}{2}(\text{Wisley} - 2.1) + \frac{1}{2}(\text{Edenbridge} - 0.4) + \frac{1}{2}(\text{Long Sutton} + 0.5) + \frac{1}{2}(\text{Plumpton} + 2.3)\right]$
37B	$\frac{1}{2.5}\left[(\text{Worthing} - 1.7) + \frac{1}{2}(\text{Littlehampton} - 1.3) + \frac{1}{2}(\text{North Heath} - 0.8) + \frac{1}{2}(\text{Eastbourne} - 0.4)\right]$
38A	$\frac{1}{4.5}\left[(\text{Bodiam} + 0.2) + (\text{Edenbridge} - 0.5) + (\text{East Heathly} - 0.3) + \frac{1}{2}(\text{North Heath} - 0.6) + \frac{1}{2}(\text{East Malling} - 1.9) + \frac{1}{2}(\text{Plumpton} + 2.2)\right]$
38B	$\frac{1}{3.5}\left[(\text{Eastbourne} - 1.1) + (\text{Plumpton} + 1.3) + \frac{1}{2}(\text{Worthing} - 2.4) + \frac{1}{2}(\text{Bodiam} - 0.7) + \frac{1}{2}(\text{Folkestone} - 3.0)\right]$
39A	$\frac{1}{4}\left[(\text{East Malling} - 0.5) + (\text{Wye} + 0.6) + \frac{1}{2}(\text{Edenbridge} + 0.9) + \frac{1}{2}(\text{Faversham} - 0.5) + \frac{1}{2}(\text{Gillingham} - 1.9) + \frac{1}{2}(\text{Bodiam} + 1.6)\right]$
39B	$\frac{1}{3.5}\left[(\text{Manston} - 1.3) + (\text{Folkestone} - 0.3) + \frac{1}{2}(\text{Faversham} - 0.1) + \frac{1}{2}(\text{Wye} + 1.0) + \frac{1}{2}(\text{Bodiam} + 2.0)\right]$
40	$\frac{1}{2.5}\left[(\text{Camborne} - 0.1) + (\text{Falmouth} + 0.8) + \frac{1}{2}(\text{Ellbridge} + 1.7)\right]$
41	$\frac{1}{2.5}\left[(\text{Hartland Point} - 3.5) + \frac{1}{2}(\text{Ellbridge} - 1.0) + \frac{1}{2}(\text{Ilfracombe} - 2.1) + \frac{1}{2}(\text{Bastreet} + 5.6)\right]$

AREA	FORMULA
42	$\frac{1}{4}$ [(Ellbridge - 1.8) + (Bastreet + 4.8) + $\frac{1}{2}$ (Camborne - 3.6) + $\frac{1}{2}$ (Hartland Point - 4.3) + $\frac{1}{2}$ (Newton Abbot-2.8) + $\frac{1}{2}$ (Slapton - 3.5)]
43A	$\frac{1}{2.5}$ [(Newton Abbot - 4.8) + $\frac{1}{2}$ (Bastreet + 2.8) + $\frac{1}{2}$ (Hawkridge + 2.0) + $\frac{1}{2}$ (Cheldon Barton - 5.6)]
43B	$\frac{1}{3.5}$ [(Slapton - 0.2) + (Starcross - 2.3) + $\frac{1}{2}$ (Newton Abbot + 0.5) + $\frac{1}{2}$ (Ellbridge + 1.5) + $\frac{1}{2}$ (Exeter - 3.4)]
44	$\frac{1}{3}$ [(Ilfracombe - 3.4) + (Hawkridge + 3.5) + $\frac{1}{2}$ (Hartland Point - 4.8) + $\frac{1}{2}$ (Cheldon Barton - 4.1)]
45A	$\frac{1}{2.5}$ [(Exeter - 1.7) + $\frac{1}{2}$ (Starcross - 0.6) + $\frac{1}{2}$ (Cheldon Barton + 1.4) + $\frac{1}{2}$ (Winfrith - 0.3)]
45B	$\frac{1}{4}$ [(Winfrith - 0.5)+ (Shaftesbury - 0.1) + $\frac{1}{2}$ (Exeter - 1.9) + $\frac{1}{2}$ (Cheldon Barton + 1.2) + $\frac{1}{2}$ (Boscombe Down -2.1) + $\frac{1}{2}$ (Everton - 1.7)]
46	$\frac{1}{4.5}$ [(Everton - 0.5) + (Southampton - 0.4) + (Littlehampton - 1.3) + $\frac{1}{2}$ (Winfrith + 0.7) + $\frac{1}{2}$ (Leckford + 0.1) + $\frac{1}{2}$ (Worthing - 1.7)]
47	$\frac{1}{2.5}$ [(Valley - 0.8) + (Botwnnog + 1.2) + $\frac{1}{2}$ (Speke - 1.3)]
49A	$\frac{1}{3}$ [(Ruthin - 4.6) + (Corwen - 1.5) + $\frac{1}{2}$ (Oswestry - 2.3) + $\frac{1}{2}$ (Llandrindod Wells - 1.5)]
49B	$\frac{1}{4.5}$ [(Brecon - 1.5) + (Llandrindod Wells - 2.0) + (Cenarth Mill) + $\frac{1}{2}$ (Corwen - 2.0) + $\frac{1}{2}$ (Stoke St.Milborough-3.2) + $\frac{1}{2}$ (Crumbland Plantation - 1.8)]
50	$\frac{1}{3}$ [(Milford Haven - 3.2) + (Carmarthen - 1.0) + (Trawscoed - 2.0)]

AREA	FORMULA
52	$\frac{1}{2.5}\left[(\text{Rhoose} - 1.9) + \frac{1}{2}(\text{Milford Haven} - 1.7) + \frac{1}{2}(\text{Usk} - 1.2) + \frac{1}{2}(\text{Cannington} - 5.1)\right]$
Isle of White	$\frac{1}{2.5}\left[(\text{Shanklin} + 1.1) + \frac{1}{2}(\text{Everton} + 0.1) + \frac{1}{2}(\text{Littlehampton} - 0.7) + \frac{1}{2}(\text{Southampton} + 0.2)\right]$

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Ag Mem 781a and 783a, 797a

Correction to Ag Mem 781, 783 and 797

Formulae have been calculated using Average Annual Rainfall for Rhoose of 647 instead of 947 mm.

Corrected Formulae:

Ag Mem 781
Area 50 0.85 x Rhoose not 1.88 x Rhoose

Area 52 1.46 x Rhoose not 3.23 x Rhoose

Ag Mem 783
Area 52 (Rhoose -1.9) not (Rhoose -6.0)

Ag Mem 797
Area 52 Areal Return to Capacity Date 1975-76

Oct 21 31 days late

Any comments or suggestions on this paper should be referred to the author.

Meteorological Office
Bracknell

April 1976